“Effect of different manures on the growth and survival of carps species from fry to fingerlings”

Final synopsis for Ph.D thesis submission

Submitted to

Department of Biosciences,

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Submitted by

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Date:

From

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Through proper channel

Sir,

Subject: Submission of the Research Synopsis- reg.

With reference to the subject cited above, I am herewith submitting the synopsis of my Ph.D. program in the Department of Biosciences, Mangalore University. The proposed research topic entitled **"Effect of different manures on the growth and survival of carps species from fry to fingerlings".** This is for your kind information and further needful.

Thanking you.

Yours faithfully

(**Rajanna C.**)

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1. Introduction

The development and expansion of aquaculture industry is linked with the availability of quality seed. Carps being the main stay of Indian aquaculture, the technology of its seed production has long been perfected and is a practice in a large scale to cater the seed demand of the sector. India is a carp dominant country because the wide tolerance of carps to adverse water quality conditions and has good market in the country. The country is not self-sufficient in meeting the desired quantum of seeds of all the principal carp species.

The survival and growth rate of Indian major carps (IMC) are low in the traditional carp seed production sector when compared to the other species like common carp. The low growth rate mainly depends upon the type of rearing system adopted and stocking density Fertilization is the cheapest and simplest means of increasing aquatic productivity. Both organic and inorganic fertilizers are used in fish culture ponds. The usefulness of different kinds of manures such as poultry dropping, dung of cow, sheep and goats is established in fish culture and they are the suitable substitutes for the costly feeds and inorganic fertilizers currently in use (Singh et al., 2013a and Mohapatra et al., 2018).

Inland water bodies including rivers, tanks streams, flood plain lakes, wetlands, estuaries, estuarine wet lands, brackish water, backwater and mangroves are major resources. Some of these are being used for irrigation purpose and also utilized for fish culture to some extent by creating awareness among the fish growers. Judicious organic fertilization of ponds can eliminate the need for supplementary feeding. The use of manures such as poultry manure, dung from cow, sheep, goat or pig is well established (Priyadarshini, 2011). Plankton

perform other important functions in pond aquaculture - a net producer of dissolved oxygen, which is indispensable for fish growth and the most important link of ammonia-nitrogen, which is excreted by fish (Gangadhar, 2017).

The Indian major carps are native of river Ganga and Brahmaputra rivers. Their seeds were collected during monsoon season and introduced in several parts of the country. But inconsistent supply, differential size, disease issues were bothering the sector. After the invention of induced breeding technology using synthetic hormones, the carp culture area particularly under Indian major carps has increased significantly. In spite of that fish seed is the critical input for culture in ponds and natural tanks. To have consistent supply of quality fish seed, we need to identify the better system and good package of practice with sound economical feasibility (Mohapatra et al., 2018).

There are 33500 non-conventional water bodies available in the state of Karnataka. Apart from that nearly 19200 small tanks are available in Karnataka, about 60% them are seasonal, where water retains only 5-6 months. These water bodies can be effectively utilized for fish seed production. But it demands the suitable package of practice which is technically and economically viable. Organic manures stimulate the growth of fish food organisms both phytoplankton and zooplankton. The conventional practice of use of organic manures is to apply a single large dose at the beginning of the culture period. Whenever refertilization is done, the time gap between two consecutive applications is often too long. The optimum time interval between refertilization is usually one month. Moreover, the application of large doses of organic manures results in deterioration of water quality. Further, the nutrients can be retained in the water only for a short period as they are quickly lost from the water body (Hepher, 1967; Jasmine et al., 2011). Therefore, the plankton production is not sustained for a longer period. This fact leads to wastage of fertilizer resulting in economic losses to the farmer. Therefore, an ideal pond fertilization practice should involve such manures or fertilizers, which supply all the nutrients and gases in required quantities so as to achieve the maximum biological productivity, which in turn will result in maximum yield of fish (Hussein, 2012).

Poultry dropping contains all the major nutrients (N, P and K) and trace elements. Poultry manure was the best for production of plankton and fish (Natarajan, 1977). The better performance of poultry manure was attributed to the greater concentration of phosphorus in this, as compared to cattle- dung which is rich in nitrogen content while poor in phosphorus content. Excess use of poultry dropping as pond manure may avert many problems like

eutrophication, algal bloom and fish mortality. Besides, this study standardized the required number of poultry birds to manure one hectare pond by maintaining favourable water quality parameters and better survivability of fish (Das et al., 2020).

Fish seed production in commercial scale is one of the economically promising enterprises. Though aquaculture production models are highly dynamic, unless we assess the economics and understand the scale of economy of any given activity, system will not sustain. Since supply and demand of carp seed are variable the cost of seed also varies. On the other hand, farmers and entrepreneurs tend to go under great loss by investing in aquacultural activities without understanding the economics of seed production and fish farming in ideal condition (Shivakumar *et al.,* 2014). With the growing requirement for quality carp seed, there is increasing need for establishment and expansion of fish seed production centers in the region to meet the demand. Proper planning along with calculative step for scientific designing and construction of a fish seed production farm is very important for developing it as a productive and economically sustainable enterprise. The total carp fry production in India was increased from year to year (1986-2019). Quantified data on larger size fingerlings and/or yearlings are not available, although it is much needed for grow out culture (Radheyshyam, 2010). The total fish seed production in India was 5,21,706 lakhs fry in 2019-20. In Karnataka, total fish seed production was 5816.50 lakh fry in the year 2019-20 (Anonymous, 2020).

In aquaculture system seed and fertilizer occupies 50% of the total cost. The excess feed and fertilizers pose a great threat to balance in the pond eco system and also increase the cost. Hence the pond management plays an very important role in achieves good growth and survival of carp seed. Hence, it is very important to minimize this cost of production by utilizing locally available manures and fertilizers in the sustainable production of carp seed.

2. Review of literature

Fish culture in ponds has been known to man since more than three millennium age and it is now practised with varying sophisticated technologies and success on every continent (Hora and Pillai, 1962 and Brown, 1983) Scientists have presented an account of the history of fish culture in the world. Fertilizers used in aquaculture are the same ones which used in traditional agriculture. Scientific studies on fish culture by using different organic and inorganic fertilizers were started only since the beginning of this century. Systematic investigations in fish pond fertilization were first conducted in Germany. In India

Jhingran (1982) and Edwards (1980) presented a view of recycling of organic wastes in aquaculture with emphasis on the tropics. Chakravarti and Jana (1984) reviewed the utilization of organic wastes in fish culture. The use of poultry manure deserved priority in fish production/ pond productivity followed by vermin compost and cow dung (Abhishek Kumar *et al*., 2019).

2.1. Factors influencing the rate of application of manure

Hepher (1967) identified three groups of limiting factors affecting the dose of organic fertilizers applied *viz*., Physical chemical, biological and economical. They are also applicable to organic manures. The important limiting factors affecting the dose of fertilizer applied in ponds are discussed below

2.2. Physical factors:

Temperature

Water temperature above 18 $^{\circ}$C and up to 30 $^{\circ}$C appears to be optimum for good microbial development in a manure loaded pond and for adequate production of natural foods. If the optimum water temperature is 24.85 to 31.16 $^{\circ}$C it enhance the synthesis of phytoplankton biota which stimulates the growth performance of fish species (Schroeder, 1980). The water temperature has significantly affected the average body weight gain by the fish. The analysis of the data indicates temperature ranges from 14.9 to 26.9 ^{0}C revealed that the temperature of water significantly influenced the total length and weight of the Carps (Abhishek Kumar *et al*., 2019). In addition to temperature fish and pH also play role in pond productivety.

2.3. Biological factors:

Pond bottom respiration (DO)

Decline in dissolved oxygen can be expected during night due to eutrophication consumption of oxygen by fishes,by phytoplankton in the absence of light if excessive doses of organic manure are used (Hussain *et al*., 2011). Tropical fishes have more tolerance to low DO than temperate fishes. Gogoi *et al*., (2015a) opined that variation in DO concentration in aquatic bodies might be caused due to seasonal variation in temperature and fluctuations of photosynthesis and respiratory activities of the aquatic biomass. The low level of dissolved oxygen was noticed in integrated poultry farming ponds, especially in winter months, reflects this indicates the richness of organic matter, which consumes large amount of dissolved oxygen in the process of decomposition (Singh *et al*., (2013b).

Oxygen budget of the pond: **(BOD)**

The BOD of manure is full measure of its potential biological activity and quality. A 24hr BOD is often adequate to estimate these values. According to Bhatnagar *et al*. (2004) the BOD level between 3.0-6.0 ppm is optimum for normal activities of fishes; 6.0-12.0 ppm is sub lethal to fishes and >12.0 ppm can usually cause fish kill due to suffocation. Santhosh and Singh (2007) recommended optimum BOD level for aquaculture should be less than 10 mg/l but the water with BOD less than 10-15 mg/l can be considered for fish culture. Adhikari (2017) concluded that dissolved oxygen cannot move rapidly into saturated water soil, and pond soils become anaerobic below a depth of few millimeters.

Dissolved Organic Matter (DOM)

Organic fertilizers act as an energy source for bacterial growth, but the aerobic decomposition of organic matter by bacteria was an important drain of oxygen supplies in ponds (Veronica *et al.,* 2014). The presence of total solids in pond water stimulated the growth of planktonic biomass and contributed towards the primary productivity of pond ecosystem. Decomposition of organic manure in fish pond is carried out by bacteria, fungi and actinomycetes. Periphytic biota, including these organisms would have contributed to higher nutrient release for periphytic growth as stated by Gangadhar *et al*., (2017a)**.**

2.4. Chemical factors

pH

In organic manure used ponds, presence of soil substrate caused significantly lower value of pH, dissolved oxygen, dissolved organic matter and phosphate-phosphorus and significantly higher free CO_2, alkalinity, hardness, ammonia, nitrite and nitrate contents, compared with those in the absence of soil, revealing enhanced microbial mineralization in the presence of soil (Pratap Chandra das *et al*., 2005)**.** According to Santhosh and Singh (2007) the suitable pH range for fish culture is between 6.7 and 9.5 respectively.

Alkalinity

Carbonates and bicarbonates are the most common and important components of alkalinity. A total alkalinity of at least 20 ppm is necessary for good pond productivity. Water with high alkalinity and similar hardness levels has a neutral or slightly basic pH and does not fluctuate widely. The total alkalinity of the pond ranges in between 304 to 584 mg/l. The

higher alkalinity is probably due to natural and a rocky characteristic of the soil as observed by Shukla *et al*., (2019**)**.

Carbon dioxide (CO_2)

The primary sources of carbon dioxide in fish ponds are derived from respiration by fish and the microscopic plants and animals that comprise the fish pond biota. During the night, the respiration of pond organisms produces carbon dioxide, which accumulates to a maximum (usually around 10 to 15 mg/l) at dawn. According to Ekubo and Abowei, (2011) tropical fishes can tolerate CO_2 levels over 100 mg/g , but the ideal level of CO_2 in fish ponds is less than 10 mg/l. Chakrabarti (2017b) observed when the conversion of carbon dioxide to organic matter by photosynthesis is greater than the available carbon dioxide from biotic respiration and organic matter decomposition, required carbon dioxide is drawn from bicarbonate reserve. Low alkalinity indicates that CO_2 is not available particularly in latter phases of the day as a result photosynthesis stops due to lack of CO_2.

Ammonia (NH_3^-)

Ammonia is the by-product from protein metabolism excreted by fish and bacterial decomposition of organic matter such as wasted food, faeces, dead planktons, sewage etc. The unionized form of ammonia (NH_3^-) is extremely toxic while the ionized form (NH_4^+) is not and both the forms are grouped together as “total ammonia”. The healthy phytoplankton population removes ammonia from water. The addition of salt @ 1,200-1,800 kg/ha can be used to reduce the toxicity of ammonia in water. Biological filters may be used to treat water for converting ammonia to nitrite and then to harmless nitrate through nitrification process (Chakrabarti, 2017).

Nitrite (NO_2^-)

Nitrite is an intermediate product of the aerobic nitrification bacterial process, produced by the autotrophic *Nitrosomonas* bacteria combining oxygen and ammonia.. The desirable range of NO_2 is 0-1 mg/l and acceptable range is less than 4 mg/l NO_2-N (Stone and Thomforde, 2004). The concentration of 0.2-0.5 mg/L of dissolved nitrogen is considered optimal for productive ponds while below 0.1 mg/1 indicative of poor productivity (Chakrabarti, 2017a). Nitrite concentration increased with the progress of the experiment and with the increase in the integration and reaching peak values range of 0.016- 0.062 mg/l,

0.015- 0.074 mg/l and 0.016-.092 mg/l in non-integrated, integrated with 10 chicks and with 20 chicks' ponds, respectively in the winter months was recorded by Singh *et al*., (2013b).

Nitrate (NO_3-N)

Nitrate is relatively nontoxic to fish and not cause any health hazard except at exceedingly high levels of above 90 mg /l (Thomforde, 2004). Nitrate concentration in the range of 0.42- 0.98 mg/l, 0.62- 1.28 mg/l and 0.67-1.52 mg/l in non-integrated, integrated poultry birds with increased with the progress of the experiment and with the increase in the poultry bird's integration density and reaching peak values in the winter months. The stagnant level of the nitrate during winter months might be due to the negligible activity of the nitrifying bacteria (Nitrobacter) at very low temperature this was observed by Singh *et al*., (2013b).

2.5. Plankton

2.5.1. Phytoplankton

Phytoplankton is the autotrophic (self-feeding) components of the plankton community and a key part of oceans, seas and freshwater basin ecosystems. Like land plants, they take up carbon dioxide, make carbohydrates using light energy, and release oxygen. They are what is known as primary producers of the ocean the organisms that form the base of the food chain. Total 12 genera of phytoplankton comprised mainly of four groups (Chlorophyceae, Cyanophyceae, Bacillariophyceae and Euglenophyceae and the other phytoplankton groups recorded from the pond are Dinophyceae and Chrysophyceae. Among phytoplankton the most common genera were *Chlorella* sp, *Spirogyra* sp, *Ulothrix* sp, *Volvox* sp, *Anabaena* sp, *Microcystis* sp, *Nostoc sp, Oscillatoria* sp, *Navicula* sp, *Pinnularia* sp, *Euglena* sp *and Trachelomonas* sp was recorded by Sasmal *et al*., (2010).

2.5.2.. Zooplankton

Zooplankton is a type of heterotrophic plankton that range from microscopic organisms to large species, such as jellyfish. Zooplanktons are found within large bodies of water, including oceans and freshwater systems. The Copepoda was the most dominant group. Cladocerans, which formed substantial proportion of the total plankton composition in the manured treatments, were absent from the control treatment as observed by Prithwiraj Jha (2004). The zooplankton abundance was higher than phytoplankton, which might be due to

heavy manuring with organic fertilizer (cattle dung) (Rahman *et al.*, 2008). Zooplankton was recorded as cladocera and protozoans. *Daphnia sp, Moinasp, Cyclops sp, Diaptomussp, Asplanchnasp, Brachionussp and Keratellasp* were among the most abundant zooplankton genera as recorded by Sasmal *et al*., (2010).

2.6. Fish growth and survival

The final body gain in fishes reared with poultry manure and fed t supplementary diet in ponds were improved compared with those reared with cow manure was observed by Nord Garden *et al*., (2003). The raw cattle dung treated pond gives 44.20 gram average weight of fish which is higher than other compost treated pond without inorganic fertilizers and supplementary feed as recorded by Shukla *et al*., (2019). Jasmine *et al*., (2011) conducted an experiment to study the effect of fertilizers (organic as cow dung and in-organic as triple super phosphate) in supplemented ponds on the growth of carps. The results showed that fish production was significantly higher in pond received cow dung than in the treatment pond received triple super phosphate. Fish production in cow dung treatment was 1.45 times greater than the other treatment. Safi *et al*., (2016) concluded that moderate application of poultry dropping at the rate of 1 chick/ 11.1 sq. m is ideal in maintaining suitable water quality and plankton productivity which ultimately enhanced fish growth and overall higher production of fish per unit area. Excessive uses of poultry dropping deteriorate water quality, resulting in eutrophication and stress to the culture fish.

2.6.1. Catla

Catla also known as the major South Asian carp, is an economically important South Asian freshwater fish in the carp family Cyprinidae. Catla has large and broad head, a large protruding lower jaw, and upturned mouth. Abdullah Al Mamum *et al*., (2014) reported that the final average weight (g) was 469.03±5.77g, 347.9±1.73 g and 321.67±1.15 g, respectively. Growth of catla was always higher than those of rohu and mrigal during the entire experimental period.

2.6.2. Rohu

Rohu (*Labeo rohita*) is the most important among the three Indian major carp species used in carp polyculture systems. This graceful Indo-Gangetic riverine species is the natural inhabitant of the riverine system of northern and central India, and the rivers of Pakistan, Bangladesh and Myanmar. Sulochana and Gaur (2010) observed that survival of rohu fry was

78.4 % in vermicompost manured ponds which was sufficiently higher in comparison to poultry manure (65%) and cow dung (42.8%). Best survival by vermicompost may be due to least H_2S, free CO_2 and ammonical nitrogen released on decomposition and good amount of plankton production.

2.6.3. Common carp

The common carp (*Cyprinus carpio*) is a widespread and economical freshwater fish of eutrophic waters in lakes and large rivers in Europe and Asia. Rahman *et al*. (2008) observed that common carp growth, in polyculture with rohu was higher in the presence of artificial feed and negatively correlated with natural food availability. They also recorded higher ingestion of benthic macro invertebrates, copepods and rotifers and a lower ingestion of phytoplankton by common carp. The daily growth rate of common carp is faster under poultry integration as compared to other manure (Muhammad, 2011 and Endebu, 2016).

2.7. Organic manures

Organic fertilizers act as an energy source for bacterial growth, but the aerobic decomposition of organic matter by bacteria was an important drain of oxygen supplies in ponds (Veronica *et al.,* 2014). Different organic manures used as semi dried pig manure at 4,000 kg/ ha/ year, poultry manure at 6,000 kg /ha/year, cow dung at 10,000 kg /ha/ year, vermicompost at10,000 kg/ ha/ year and vermicompost at 15,000 kg /ha/year. In the beginning of experiment, initial dose was equal to 25% of the total amount of the manure applied and remaining amount was given in equal split doses at fortnightly intervals (Godara *et al*., 2015). The application of rice straw extract as an organic manure to produce sufficient quantity of phytoplankton and zooplankton for nursery fish pond management is not only better but also safer than the raw animal dung (Hanaa et al., 2014).

2.8. Cost-economics of fish seed production

Fish seed production includes egg to spawn production for 3 days, spawn to fry nursing for 15-20 days, fry to fingerling rearing for 60-90 days and fingerling to yearling rearing for 8-9 months. Thus the carp seed may be categorized at its final size into spawn (6-8 mm size), fry (20-25 mm size), fingerlings (100-150 mm size) and yearlings (100-200 g weight) (Radheyshyam, 2010). Debnath et al. (2018) analysed the economics of nursing, rearing and culture Indian major carps in a kani of pond (0.16 ha) in Tripura. Net profit

obtained was Rs. 27,680/- in nursery phase, Rs. 16,110/- in rearing phase and Rs. 54,250/- in grow-out phase. Benefit cost ratio was highest in nursery (1.85), followed by in grow out(1.82) and rearing phase (1.40). This suggests for opting fish farming as profitable livelihood enterprise. Saikia et al. (2020) assessed the economics of production of fish fingerling, advanced fingerling and yearling by raising fish spawn for three successive years. The study concluded that the fish seed rearing and farming was profitable venture for the locality. The study revealed that, fixed cost is about for Rs. 20,000/ha for renovated pond and operational cost is about Rs. 2,00,825/ha required for the 50 days seed rearing period. Net profit of fish seed rearing among the species reared (catla, rohu, common carp and grass carp) were highest in grass carp following by others. The BC ratio of catla is 3.73, rohu is 3.98, common carp 3.11 and grass carp is 4.48. The return on investment is high in grass carp (3.48) followed by rohu (2.98), catla (2.73) and mrigala (2.48).

3. Objectives

The present study is under taken with the following objectives:

1. To study the effect of different manures on growth and survival of carps during rearing from fry to fingerlings

2. To study the effect of organic manures on pond productivity of ponds

3. To evaluate economics of seed production using different organic manures

4. Materials and methods

The experiment was conducted at Zonal Agricultural and Horticultural Research Station, Bramhavara (UAHS, Shivamogga). The trails were conducted in the cement ponds having a diameter of 6 ft X 2.5 ft X 2.0 ft with a soil base of 15 cm. Lime applied @ 200 kg/ha and sun dried for a week. The cement ponds were filled with water from bore well up to 50% level of the ponds. After a week, fermented (fermentation for 20 day) cow-dung and poultry manure was added @ 10,000 Kg/ha and 5000 Kg/ha, at regular intervals split dose of manures was applied. Proximate composition of manures was analysed before applying them. Water level was raised to 2 feet and maintained same throughout the experimental period. There were three treatments with three replications each.

T1: Cow dung @ 10t/ha

T2: Poultry manure @ 5t/ha

T3: Poultry manure 50% @ 2.5 t / ha + Cow-dung 50% @ 5 t/ha

A completely randomized design was followed in the allocation of treatments to the various cisterns. The important steps involved in the studies were preparation of cisterns, fertilization, stocking of fishes, sampling of fishes for their growth along with recording of water parameter data, and plankton collection.

4.1. Preparation of cement cisterns

The experimental cement cisterns were allowed to sundry for one week and provided with a soil base uniformly spread up to a thickness of about 15 cm. Since the soil characteristic was acidic in nature, it was treated with quick lime (CaO) at the rate of 200 kg/ha. After 2-3 days the cisterns were filled with water from bore well up to 2 ft and maintained throughout the experimental period.

4.2. Fertilization

Fresh poultry manure was collected and dried in shade to reduce the moisture content and collected the fermented cow dung. In the first trial all the cisterns were applied with fertilizers at the fixed rate of 5000 kg / ha of cow-dung, 2500 kg of poultry manure and cow dung and poultry manure at the rate of 50% +50% on dry weight basis. The initial dose of manure was applied in dry (solid) form in all the cisterns. After Seven days of initial fertilization, the water level in the cisterns was raised to 2 ft and maintained at that level till the completion of the experiment. Applied 50% of the manures initially to all the cement cisterns.

4.3. Refertilization with split doses

The second dose of fertilization was done after 20 days of the first application, the dosage of organic manures applied was in split doses according to the treatments. Refertilization of the manures was applied in liquid form *i.e*., the dry manure required for an application was made into slurry by addition of water for easy broadcast and uniformly spread all-overs the surface of the pond. The application of manures was always done in the morning hours as suggested by Woynarovich (1980a).

4.4. Stocking of fishes

The experimental cement ponds were stocked with carp fry, 3-4 days after initial application of organic manures.Uniform sized fry of catla (*Catla catla*), rohu (*Labeo rohita*), common carp (*Cyprinus carpio*) were stocked in all the cement ponds in a ratio of 4; 3; 3 in each cistern. Fish seeds were procured from Bhadra Reservoir Project Fish Seed Production centre. Fish seeds were fed with 10% of their body weight (Rice bran : Groundnut oil cake @ 1:1 ratio).

4.5. Sampling of manure, water, plankton and soil

Sampling was carried out between 7 am to 10 am before the addition of fertilizer doses. Water and plankton samples were collected from each cistern at weekly intervals, while soil samples were collected fortnightly intervals. On each sampling day, the air and water temperature were also recorded. Soil samples were taken from two to three places in each cistern, mixed, shade dried, pulverized and sieved through an ISS No. 30 sieved and stored in polythene bags for analysis

A conical plankton net (60 mm) mesh size) having a rectangular mouth with an area of 200 cm^2 (20x10 cm) was used to collect the plankton samples. The net was dragged just under the water surface along one side of the cistern, thus filtering about 100 l of water. The collected plankton samples were then preserved in 4% formalin solution (Sladeck *et al*., 1982) and stored in labelled polythene containers for qualitative and quantitative analysis.

4.6. Sampling of fish

In order to assess fish growth, a minimum of 50% of each species in every cistern was caught once in ten days intervals, and the length and weight of each fish were recorded. On complition of the experiment, the cisterns were drained completely and the individual length and weight of each species of fish recorded from each cistern. The length of fish was recorded to the nearest millimetre, while the weight was taken to the nearest gram.

4.7. Analysis of samples

a. Manure

Representative samples of both the organic manures were shade dried, pulverised and sieved through a ISSNo.30 sieve. The sieved powder was analysed for total ash, acid insoluble ash, organic matter (lose on ignition), total nitrogen (Kjeldahl’s methods) and total phosphorous.

b. Water

Water inside the cement cisterns was directly used for the estimation of air and water temperature, dissolved oxygen, free carbon dioxide, carbonate and bicarbonate alkalinity, pH, total ammonia, nitrite, nitrate by using HATCH electronic recording machine. (APHA, 1995). The water except dissolved organic matter and orthophosphate were estimated separately by adopting standard methods. Dissolved organic matter was determined by the procedure recommended by Jhingran *et al*., (1969) and total orthophosphate was determined by the ascorbic acid method given in (APHA, AWWA, WPCF, 1976).

c. Soil

Soil samples were analysed for texture, pH, electrical conductivity, organic carbon, available phosphorus and available potassium. The texture of the soil was determined only at the beginning of the experiment, by the gravimetric method (Jhingran *et al*., 1969). The soil pH as measured with a pH meter (HATCH) The electrical conductivity was measured using a conductivity meter (Elico, model cm- 80). Organic carbon was determined by the chronic acid method (Datta *et al*., 1962). Available phosphorous was determined by Bray's method (Bray and Kurtz, 1945). Available potassium was estimated by the flame photometer method (Stanford and English, 1949; Toth and Prince, 1949). To measure the intensity of colour developed in the estimation of organic carbon and available phosphorus a klett-summerson Photo- Electric Colorimeter was used. In determining available potassium, a flame photometer (Elico model) was employed.

4.8. Plankton analysis

The estimation of both qualitative and quantitative planktons was made. In qualitative analysis, identification of plankton was made up to the generic level. The quantitative analysis was done by the direct census method (Jhingran *et al*., 1969) and by determining the wet and dry weights.

a) Direct census method: in this method, a Sedgwick rafter type plankton counting cell, made of transparent plastic, designed to hold 1 ml of sample and whose surface divided into 100 equal squares, was used. The plankton samples were diluted to about 50 to 60 ml and mixed thoroughly. From the above suspension, 1 ml of sample was taken and counted under 100 x magnifications, using a compound microscope. Whenever the collection of plankton was too concentrated, further dilution was made to facilitate easy counting. For phytoplankton, only 10 squares were chosen at random whereas for zooplankton all the 100

squares were counted. In the case of filamentous algae, like *Melosira* sp**,** *Anabena* sp, etc. about 350-micron length was considered as one unit, and for colonial forms, a single colony was considered as one unit. After counting the number of plankton per litre then computed for pond water.

b) Wet weight: The plankton samples for analysis of quantitative method the samples were through a piece of blotting silk cloth No. 30 (mesh size 60m) and collected. The residue made free of excess moisture by using blotting paper, and transferred to an aluminium foil of known weight and weight accurately. The density of plankton in terms of wet weight was expressed in mg/100L of pond water.

C) After determining the wet weight, the plankton material in the aluminium foil was dried in a hot – air oven at 60^0c for 24 hours and cooled in a desiccators. The density of plankton in terms of dry weight was expressed as mg/ 100 L of pond water.

4.9. Statistical data analysis

The ANOVA technique was applied to the data on fish growth, weight, survival number and net fish production (g/cistern/culture period) to compare species, treatments, their combinations and also test for interaction between species and treatments. Duncan's Multiple Range Test (DMRT) analysis was carried out to know the significance of the different treatments in fish growth.

5. Results

The investigations were undertaken to know effect of two manures (Cowdung, Poultry manure and Cowdung + Poultry manure) on physico-chemical qualities of water, density and diversity of planktons, growth and production of Catla, Rohu and Common carp. In all the experiments, effect on water qualities were recorded at regular intervals and compared among treatments. The phytoplanktons and zooplanktons were analysed in both qualitative and quantitative manner. The growth and production of each fish species were regularly recorded and statistically analysed.

5.1. Chemical composition of poultry manure

Three lots of poultry manure were used during the course of study. On an average, the moisture content varied between10 to 15%. The total ash content varied from 23.68 to 45.14% acid insoluble ash from 9.75 to 11.20%, organic matter from 71.29 to 76.32% total nitrogen from 2.34 to 2.82% and total phosphorus (P_2O_5) from 5.51% to 5.91%, all values

expressed on dry weight basis. Thus, it could be seen that the composition of poultry manure did not vary significantly between the three lots used.

5.2. Chemical composition of cow-dung

Raw cow-dung is reported to be better than dry cow- dung, for the fast production of plankton, because of the ready availability of nutrients present in the former. The percentages of total nitrogen and P_2O_5 in cattle-dung used in the first application were 1.20 and 2.80 respectively, whereas, these in the second application were 0.98 and 2.04 respectively. In the present study, it was seen that P_2O_5 content of cattle-dung was more than that of its nitrogen content. In addition to this, the fluctuation in nitrogen and P_2O_5 was too much from one sample to the other. The chemical composition of cattle- dung varies depending on the age, feed and condition of the animal. The cattle dung has high content of organic matter.

5.3. Physico-chemical properties of water

a. Temperature

Water temperature ranged from 25.50 °C to 30.50 °C during the period of observation.

b. Dissolved oxygen

The average dissolved oxygen concentrations ranged between 4.73 and 6.43 ppm in CD treatments, 3.36 and 8.26 ppm in PM treatments 4.73 and 7.23 ppm in CD + PM treatment during the experimental period. The minimum dissolved oxygen concentration was 3.36 ppm recorded in PM cistern on the initial day, while the maximum observed was 8.26 ppm in PM cistern on the 42^{nd}day. The pre-fertilization levels of dissolved oxygen (first sampling day) were generally the lowest values for the treatment period in many cisterns. the mean dissolved oxygen level for the period of study was highest in Pm treatments followed by CD and CD+ PM treatments in that order.

c. Free carbon dioxide

The average free carbon dioxide concentrations ranged from nil to 2.16 ppm in PM treatments, 4.57 to 8.33 ppm in CD treatments, 2.67 to 0.00 ppm in CD+PM treatments during the period of study. The maximum free carbon dioxide concentration was 8.3 ppm

recorded in CD1cistern on the 21st and 28thday. In CD, and PM treatments, the high values of free carbon dioxide were observed on the first sampling day, prior to initial fertilization. In CD cistern 1 and 2 recorded a higher value than that of first sampling day. While CD cistern recorded more or less equal values on the 21st and 28th days. The mean carbon dioxide level for the period of experiment was highest in CD treatments, followed by PM and CD+PM treatments in that order.

d. Alkalinity

Carbonate Alkalinity

Average concentration of carbonate alkalinity varied from nil to 12.00 ppm in PM treatment1.0 to 6.00 ppm in CD+PM treatment and 4.0 to nil ppm in CD treatment, during the period of study. The maximum carbonate alkalinity was 12.00 ppm, observed in PM1cisterns on the 21st and 35th days.

Bicarbonate alkalinity

The average bicarbonate alkalinity concentrations varied from 29.00 to 56.33 ppm in CD treatment, 27.67 to56.33.ppm in PM treatment, 28.00to 52.00.ppm in CD+PM treatment during the experimental period. The minimum bicarbonate alkalinity was observed on the first sampling day in all the cisterns, the least being 25.00 ppm in PM_2 cistern. The minimum bicarbonate alkalinity was observed on the first sampling day in all the cisterns, the least being 25.00 ppm in PM_2 cistern. The maximum bicarbonate alkalinity of 61.00 ppm was recorded in PM_1 cistern on the 49th day. The mean concentration of bicarbonate alkalinity over the period of study was the highest in CD and PM treatments, followed by CD+PM, treatments in that order.

f. pH

The average water pH ranged from 7.67 to 8.13 in CD treatment, 7.40 to 8.77 in PM treatment, 7.73 to 8.40 in CD+PM treatment, during the experimental period. The pH was lowest in all the cistern on the 7th day. However, the difference in pH between treatments did not appear to be significant. In general, the pH of water remained slightly alkaline throughout the period of experiment (Table 8 and Fig. 6).

g. Dissolved organic matter

The average dissolved organic matter concentration fluctuated from 3.47 to 11.07 ppm in CD treatment, 4.40 to 10.33 ppm in PM treatment, 4.37 to 10.60 ppm in CD+PM treatment, during the period of observation .The lowest values were recorded on the first sampling day, prior to initial fertilization, the minimum dissolved organic matter concentration being 2.4 ppm in CD3 cistern on the 63rd day. The mean dissolved organic matter concentration for the period was the highest in CD treatment, followed by PM and CD+PM treatments in that order.

h. Nitrite

The average Nitrite – Nitrogen concentration ranged from traces to 0.18 mic g at N/L in CD treatment, traces, to 1.08 mic g at N/L in PM treatment, traces to 0.57 mic g at N/L in CD+PM treatment during the period of study. The maximum nitrite concentration of 1.32 mic gat N/L was observed in PM2 cistern on the 35th day.

i. Nitrate

The fluctuation in nitrate content were relatively less and also gradual in CD and CD +PM treatments, whereas the fluctuation was sharp in PM and CD+ PM treatments being more pronounced in the later treatment. The average nitrate concentrations ranged from 0.26 to 2.43 mic g/at n/l in CD treatment ,2.20 to 7.78 mic g at n/l in PM treatment, and 2.00 to 4.22 mic g at n/l in CD + PM treatment during the period of investigation. The maximum nitrate concentration observed was 9.55 mic g at n/l in PM3 cistern on the 7th day. The mean nitrate concentration for the duration of the study was the highest in PM treatment, followed by CD+PM, and CD treatments in that order.

j. Total phosphorus

The average concentration of total phosphorus varied between traces and 0.30 mg at p/l in CD treatment 81.67 and 468.33 /ug at p/l in PM treatment, 40.33 and 161.00/ug at p/l in CD+PM treatment during the period of observation .The maximum total phosphorus concentration of 515.00/ug at p/l was recorded in PM1 cistern on the 21st day. The mean total orthophosphate concentration was higher PM treatment when compared to the other two treatments which were comparable.

k. Total Ammonia

The average total ammonia concentrations varied from 0.10 to 1.80 micro gram at N/l in PM treatment, 0.11 to 1.55 micro grams at N/L in CD treatment, 0.08 to 1.31 micro g at N/L in CD+PM treatment. During the period of observation, the maximum total ammonia concentration recorded in the present study was 1.75 mi g at N/L in PM1 cistern on the 21st day. The mean total ammonia level over the period of study was the highest in PM treatment, followed by CD and CD+PM treatments.

5.4. Plankton

The data on the qualitative composition of plankton, fluctuation in density in terms of number (No/l), total plankton density (No/l), Wet weight (mg/100 L) and dry weight (mg/100L) and statistical analysis of the data, in the four treatments during the experiment are presented here under.

a. Phytoplankton

Density

Differences in phytoplankton density between treatments were not well defined until the 35thday, after which, PM treatment can be said to have had the highest density, followed by CD+PM and CD treatments in that order. There were less fluctuations in phytoplankton population in both PM and CD+PM treatments as compared to CD treatment. The average density of total phytoplankton varied from 20 to 80591.0 No /L in CD treatment, 22.0 to 4174.0 No/L in PM treatment, 21 to 3831 No/L in over the experimental period. Except in PM treatment the lowest numbers of phytoplankton were observed on the first sampling day, prior to initial fertilization. The maximum density was 80591.0 No/L recorded in CD treatment on the14th day.

Qualitative Composition

The data on the qualitative occurrence and density of phytoplankton in the different treatments during the study are tabulated. The phytoplankton in the different treatments belonged mainly to the groups Cyanophyceae, Chlorophyceae, Bacillariophyceae and Euglenineae. The former two groups were encountered commonly in large, while the latter two groups were represented in small numbers and only occasionally. The green algae (Chlorophyceae) were represented to a large extent by *Coelastrum* spp., *Pediastrum* spp., *Eudorina* sp. and *Pandorina* sp. and lesser extent by *Selenastrum* spp., *Closterium* spp.

Volvox spp., *Ankistrodesmus* spp., *Ulotrix* sp., *Spirogyra* spp, and other filamentous green algae. Among the blue- green (Cyanophyceae), *Microcystis* sp., *Anabena* sp. and *Arthrospira* spp., were dominant, while *Nostoc* spp., *Oceillatora* spp., and *Lyngbea* spp, were less popular.

b. Zooplankton

Density

The average density of total zooplankton ranged from 10 to 145 no./l in CD treatments, 16 to 283 no./l in PM treatment, 13 to 190 no./l in CD+PM treatment, during the period of study. The lowest value of zooplankton in the different treatments was observed on the first sampling day, prior to initial fertilization. The highest population of zooplankton was 283 No./l recorded in PM treatment on the 28^{th} day. The mean total zooplankton density over the period was the highest in PM treatment, followed by CD+PM treatment and CD treatments, which two, however, were comparable. There was no correlation between dissolved organic matter concentration and total zooplankton number for the three treatment combined but PM and CD+PM treatment each taken individually exhibited a high positive association between the two parameters.

Qualitative Composition

The important zooplankton encountered in the various treatment during the experimental period belonged to the groups Rotifer, Cladocera, Copepod, Ostracoda, crustacean eggs and larval forms.The rotifer were found to be the most dominant group in all the treatments .the group next in abundance was Cladocera ,followed by copepod and larval forms. The group Ostracoda were encountered to a lesser extent. Generally, the Rotifers, Copepods and Cladocerans were more abundant in CD treatment. The important genera which represented the rotifer were Branchionus sp., *Keratella* sp., *Asplanchna* sp., *Trichocera* sp., *Polyarthera* sp., *Hexartha* sp., and *Filinia* sp . Cladocera were broadly classified as “other Cladocerans”. Copepods were represented by *Cyclops* sp. and *Diatomus* sp. and Ostracods were grouped as such. Larval forms included the larvae of crustaceans and rotifers.Some small protozoa were also encountered occasionally.

Total plankton density (Wet weight)

The of total plankton in terms of wet weight ranged from 0.24.00 to 105.3 mg/100 L water in CD treatment, 3.07 to 326.79 mg/100 L water in PM treatment, 1.86 to 128.36 mg/100 L water in CD+PM treatment over the duration of experiment. The lowest values in the various cisterns were observed on the first sampling day, prior to initial fertilization. The maximum plankton density was 483.4 mg/L water, recorded in PM1 cistern on the 35th day.

Total plankton density (Dry weight)

The average density of total plankton in terms of dry weight varied from 2.20 to 16.8 mg/100 L water in CD treatment.0.6 to39.44 mg/100 L water in PM treatment, 0.35 to 16.30 mg/100 L water in CD+PM treatment over the course of investigation. The maximum density of total plankton was 39.44 mg/100 L recorded in PM1 cistern on the 35th day. The mean plankton density for the experimental period was higher in PM treatment than in CD+PM treatment, but was comparable to PM and CD+PM treatments. However there was no difference between PM, CD +PM and CD treatments. There was a strong positive correlation between wet and dry weight values of plankton density over all the treatments and for the individual treatments. Further, there was a high positive association between total plankton density as number and total plankton density as dry weight for the treatments and for the individual treatments.

5.5. Fish growth

a. Catla (*Catla catla*)

Comparing the growth pattern in weight between treatments it is seen that the species grew better in PM treatment after the 30th day. The difference in growth between the treatment became noticeable from the 30th day onwards and were maintained till termination of the experiment from the average initial weight of 0.79 mg, 0.95 mg PM, 1.37 mg CD+PM. Average specific growth rate of catla was 0.36 mg CD, 0.52 mg PM, and 0.55 mg CD+PM treatments, reaching a final weight of 29.7 mg, 62.97 mg, and 23.83 mg in the three treatments respectively at the time of harvesting after 60 days of culture. The maximum growth in of catla was 70.8 mg in PM2 cistern closely followed by 62.6 mg in PM3 cistern. The growth in weight appeared best in PM treatment, followed by CD, and CD+PM treatment in that order but the differences between treatments were slight.

b. Rohu (*Labeo rohita*)

Comparing the pattern of growth in weight the treatments, it was found that the treatment PM seemed to show the best growth especially after the 40th day. In PM treatment, growth rate was good up to the 20th day. In CD+PM treatment, the fish grew better than in CD treatment after the 20th day. Rohu grew at a lower and constant rate in the CD treatment. From an average initial weight of 0.29 mg was same in all the treatments. Average specific growth rate of rohu was 0.29 mg CD, 0.40 mg PM, and 0.43 mg CD+PM treatments, reach final weights of 21.5mg, 35.27mg and 27.7mg in these three treatments respectively. The maximum growth in weight of rohu was 39.4mg, recorded in PM1 cistern. The growth in weight may be considered best in PM treatment, followed by CD+PM and CD treatments in that order.

c. Common carp (*Cyprinus carpio*)

The growth in weight of common carp was faster in both CD+ PM and PM treatments after the 30th day, as compared to the other treatment (fig). From an average initial weight of 0.28 mg CD, 0.41mm PM, and 0.41mm CD+PM. The specific growth rate was 0.24mg, 0.40mg, and 0.31mg in CD, PM and CD+PM treatments reaching final weights of 23.37 mg, 32.1 mg, and 36.23 mg in the three treatments respectively, at the time of harvesting after 60 days of culture. The maximum growth in weight of common carp was 40.2mg, recorded in CD+PM3 cistern. Common carp thus showed the best growth in weight in CD+PM treatment, followed by PM and CD treatments in that order.The pattern of growth in terms of weight resembled that of length in all the treatments but the differences in growth between treatments were more pronounced in terms of weight. The mean yield (growth) of common carp was higher in the CD+PM treatment compared to the other two treatments. While the yield in CD+PM treatment differed from PM treatment, was comparable to CD+PM treatment. However, though the yield was lowest in CD treatment, it was not different from that of PM treatment.

5.6. Net production and survival of the species

The average net production of Catla was 202.43 mg in CD treatment, 310.4 mg in PM treatment, and 280.23 mg in CD + PM treatments. From this data it is seen that the highest production was obtained in PM treatment. While the least production was182.3 mg in CD treatment, and the highest net production of 346.9 mg was obtained in PM2 cistern. The

average net production of rohu 77.9 mg in CD treatment, 102.3mg in PM treatment , 124.8mg in CD+PM treatment. Therefore, the net production of rohu was the best in CD+PM treatment and lowest in CD treatment. The highest net production of 160.7 mg was recorded in PM1 cistern. The average net production of common carp was 119.03mg in CD treatment, 192.3 mg in PM treatment, 155.13mg and CD+PM treatment. Hence the net production of common carp was the highest in PM treatment and the least in CD treatment. PM2 cistern recorded the highest production of 214.9 mg.

The average survival of Catla was 11.33, 16.88 and 16.19 in CD, PM and CD+PM treatments. However, these survival rates were comparable between treatments. The average survival of rohu was 4.36 % in CD treatment, 5.39 % in PM treatment and 7.35 % in CD+PM treatments. But these survival rates were comparable between treatments. The average survival of common carp was 6.72 % CD, 10.52 % PM treatments and 9.11 % CD+PM treatments. Thus, there was a difference in the rate of survival between treatments. The comparing the survival rate between species, the mean survival of rohu was lower than the other two species in all the treatments. The overall average survival rate of Catla was higher in all the treatments. When compare to rohu, common carp perform better. Therefore, there was difference in the rate of survival between treatments.

5.7. Cost-economics of fish seed production

The fish seed production economics analysis revealed that, total operational cost of seed production (Rohu, Catla and Common carp) was Rs. 45,932.00/acre in cow dung manure treatment, Rs. 43,032.00/acre in poultry manure treatment and Rs. 43,932.00/acre in cow dung+ poultry manure. The returns in cow dung, poultry manure and cowdung+poultry manure treatments was Rs. 53,784.00/acre, Rs. 65,580.00/acre and Rs. 65,300.00/acre respectively. The highest net profit was noticed in poultry manure (Rs. 22,548.00/acre) and cowdung+poultry manure (Rs. 21,368.00/acre) and cow dung manure (Rs. 7852.00/acre).

6. Summary

The dissolved oxygen levels were generally higher with lower fluctuations in PM and PM +CD compared to CD treatments. However, in all the treatments, dissolved oxygen was favorable for fish production. Split manuring did not bring about any marked differences in free carbon dioxide levels.

In all the treatments, alkalinity was mainly contributed by bicarbonates, which showed a gradual increase over the experimental period. Fluctuations in bicarbonate alkalinity during the latter part of the study in PM and PM + CD manuring treatments were attributed to changes in the abundance of phytoplankton and release of carbon dioxide from the decomposition of the organic manures.

The pH of water was slightly alkaline and in the range suitable for fish production, in all the treatments. Also the fluctuations in pH among treatments were very small.

Dissolved organic matter concentrations were inversely proportional to frequency of manuring and a buildup in dissolved organic matter was seen in all the treatments towards the later part of the experiment. Dissolved organic matter levels were generally higher in PM and PM + CD treatments and were associated with higher densities of blue green algae.

Total ammonia was found to be within the safe limits for fish culture in all the treatments and was generally lower in CD and CD+ PM treatments, especially during the later part of the experiment.

Nitrite levels in the four treatments were very low with no apparent difference among treatments. Nitrate levels in PM treatment quickly returned to pre-fertilization levels after every dose of split manure application and this was attributed to its rapid uptake by various pathways and also to the longer time interval between successive applications. Nitrate levels were relatively more stable in the later part of the study.

Total orthophosphate in PM treatment also showed a tendency to return to pre-fertilization levels after every dose of split manure application. This was due to the rapid removal of phosphorus from water by living organisms and its immobilization in the soil, and the longer interval between consecutive application brought about lower levels in PM and CD+PM treatments. Frequent application of cow dung and poultry manure in split doses ensured a constant supply of phosphate to the water with lesser fluctuations, associated with better plankton production.

The treatments PM and CD+PM were comparable in their efficiency of phytoplankton production. CD treatment had a lower effect in inducing phytoplankton production. Total orthophosphate and phytoplankton density were positively correlated. Shorter frequency and smaller dose split manuring encourages to a large extent the growth of desirable species of green algae and helps maintain them with lesser fluctuations in density. There was a positive

relationship between frequency of manuring and zooplankton production. Dissolved organic matter and zooplankton density showed a positive association in both PM and CD+PM treatments.

Survival of catla was high and comparable in all the treatments. Growth and yield of catla was also found comparable among treatments. Survival of rohu was comparable among the treatments PM treatment produced a higher growth and yield of rohu compared to the other treatments. Survival of common carp was high and comparable among the treatments. PM treatment showed a higher growth and yield of common carp compared to the other treatments.

Among the three species, catla gave the highest net fish production followed by common carp and rohu, in that order. Among the four treatments, PM and CD+PM were comparable in net fish seed production and better than cow dung (CD). The PM was the best yielding of all treatments. Catla was the best yielding of all species. Catla- PM was the best yielding combination and lower yield was observed in cow dung treatment. The results of the present investigation indicate that the use of cow dung, cow dung and poultry manure and poultry manure in frequent split doses at regular intervals helps maintain desirable water and soil quality, production of quality fish food organisms and promotes the growth, survival and production of fish.

The lowest operational cost of seed production was noticed in poultry manure followed by cowdung+poultry manure. The highest return was observed in poultry manure followed by cowdung+poultry manure. The cost-economic analysis indicated that, the highest net profit was obtained in poultry manure (Rs. 22,548.00/acre) followed by cowdung+poultry manure.

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